THE EXPLOSIVES ENGINEER

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Forerunner of Progress in Mining, Quarrying, Construction

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By W. H. HOLLIDAY

Views and opinions expressed by the authors of articles in this publication are their own, and they do not necessarily represent those of the publisher.

For the second time in our editorial career, we are devoting an entire issue of THE EXPLOSIVES ENGINEER to a description of the activities of one company, the Tennessee Coal & Iron Division of United States Steel Corporation. This departure from precedent was taken because of the unique circumstances involved in the growth and development of this company, known more familiarly as TCI.

TCI had its origin in the Cumberland Mountains of Tennessee, more than a century ago, when it was organized as the Sewanee Mining Company. At first, its properties consisted entirely of one small coal mine. After expanding activities to include the production of coke and pig iron, the organization, in 1886, then known as Tennessee Coal, Iron and Railroad Company, moved into the Birmingham district of Alabama. Here, it acquired the mining and manufacturing facilities of various smaller companies and welded them into one complete operation. The company was acquired by United States Steel Corporation in 1907.

Alabama's Birmingham district has been described as a geologist's paradise. Rich in mineral resources, it is one of the few places in the world where all the major raw materials for the manufacture of iron and steel are located within a compact area of a few square miles. As far as can be determined, it is the only location where large-scale advantage has been taken of such favorable geologic conditions.

Southwest of the Birmingham business district, at the crest of Red Mountain, hematite outcrops in great quantities. It is the largest easily workable deposit in the South. In the other direction from Birmingham lies the rich Warrior Coal Basin, from which are mined vast tonnages of high-quality coking coal. Limestone deposits lying in strata above the hematite vein are readily accessible. Dolomite lies near the surface and is readily procurable in open-quarrying operations.

All of these minerals – iron ore, coal, limestone, and dolomite – are brought together at the manufacturing plants of TCI, which occupy a strategic position in Opossum Valley, almost exactly centered between the various mineral deposits.

The Tennessee Coal & Iron Division of United States Steel Corporation is by far the largest steel producer in the Birmingham district. A fully integrated operation, with its own mining, quarrying, smelting, and rolling facilities, it produces approximately 100 marketable items of steel from the district's raw materials. It has a rated plant capacity of more than 3,831,000 net tons of ingots a year.

From the time it moved into the Birmingham district, TCI has maintained a policy of steady improvement of mining facilities and methods. From the old hand-mining methods of half a century ago, it has advanced in technique to the point where underground operations are now on a highly mechanized basis. Its mining activities are organized as the Raw Materials Division of the Operating Department. Further subdivisions in the Birmingham district include the Ore Mines and Quarries Works, encompassing the production and processing of iron ore, limestone, and dolomite, as well as the Coal Mines Works.

Awards of national honors for outstanding safety achievements to various units of the Ore Mines and Quarries Works attest to the importance placed on safety by the TCI organization. So effective have been management's safety program and personnel's spirit of cooperation that accident-frequency and accident-severity rates have decreased steadily in the past five years. Safety-consciousness has been so instilled in personnel that every TCI employe considers himself an important part of a team dedicated to the cause of safety.

It is with pleasure that we present a comprehensive review of the diversified operations of the Tennessee Coal & Iron Division of United States Steel Corporation. For the complete report, please turn to page 9.

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IMPOSSIBLE WITHOUT EXPLOSIVES

120 million tons of iron ore, it is estimated, were mined in open pits and underground operations last year. This photograph shows some of the highly mechanized operations which make such huge production possible.

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JOHN M. SPEARMAN

John M. Spearman

VICE PRESIDENT - OPERATIONS
TENNESSEE COAL & IRON DIVISION
UNITED STATES STEEL CORPORATION

A Biography

JOHN M. SPEARMAN, vice president in charge of operations at the Tennessee Coal & Iron Division of United States Steel Corporation, Fairfield, Alabama, is an electrical engineer, according to his college diploma. However, during his long and eventful career, he has been an operating engineer in a cotton mill; a construction engineer with a cast iron pipe company; and a draftsman and steam engineer with TCI. In addition to those activities, he has installed telephone switchboards, tested and installed machinery for a Birmingham manufacturing concern, and served in numerous and highly varied operational and supervisory jobs. He has been associated with TCI for forty years.

"Jim," as his associates call him, was born at Tallapoosa, Georgia, the eldest son of LeRoy C. Spearman. His father, a mechanical engineer, had worked in a gold mine near Tallapoosa and, for thirty years, was master mechanic at the Indian Head Cotton Mills. Young Jim learned the value of hard work as soon as he was old enough to hold a job. From the time he was nine, he never had a summer vacation. "My father believed that the best way to develop character in a child and to teach him responsibility was to put him to work," Mr. Spearman says. "Every spring, when the school term was finished, Dad had a job waiting for me. He followed that procedure with all of his children."

Jim studied engineering at Alabama Polytechnic Institute at Auburn. Extra-curricular activities included an interest in football, and, within a short time, he won a place on the varsity team as a first-string guard.

Upon graduating from the Institute in 1910, with a Bachelor of Science degree, he became a student apprentice with Westinghouse Electric Corporation in Pittsburgh, Pennsylvania. Soon afterward, he returned to the South to work for the Western Electric Company in Atlanta. From telephone work, he switched to textiles, becoming operating engineer for the Indian Head Cotton Mills at Cordova, Alabama. He left the textile industry to become a construction engineer with the U. S. Cast Iron Pipe Company, at Anniston, Alabama.

In 1912, Jim Spearman joined the TCI division as a draftsman. With the exception of two short periods when TCI reduced its operating force, he has been with the Division ever since, gradually working his way up through the ranks to one of the highest executive positions.

In 1916, he became a steam engineer at the coal mines and, a year later, was promoted to boiler foreman at Ensley. His next step upward was a long one, taking him to the superintendency of the Central Water Works.

Mr. Spearman was among the first of TCI's personnel to be given a responsible position at the Fairfield Steel Works, which was built to help meet the nation's defense requirements during and immediately after World War I. He was made turn foreman in the structural mill in 1922, superintendent of the blooming mill in 1924, and superintendent of the plate mill in 1929.

His advancement in the TCI organization was continued through the positions of assistant general superintendent and general superintendent of the Fairfield Steel Works. In 1943, he was made manager of manufacturing operations and, eight years later, was elevated to the vice presidency. In this position he has overall responsibility for both the manufacturing and the mining activities of the Division.

Mr. Spearman and his wife, the former Myrtle Thirsk of Honesdale, Pennsylvania, have three children and nine grandchildren.

Usually at his desk by seven o'clock in the morning and often remaining there until late in the evening, Mr. Spearman has relatively little time for recreation. When opportunity permits, he still enjoys attending the Auburn football games, and likes to putter around the grounds of his home on Shades Mountain, with its acre of lawn, a flower garden, and a small orchard to keep in good condition.

RALPH EMERSON KIRK

Ralph Emerson Kirk

MANAGER OF RAW MATERIALS
TENNESSEE COAL & IRON DIVISION
UNITED STATES STEEL CORPORATION

A Biography

RALPH EMERSON KIRK, manager of raw materials at the Tennessee Coal & Iron Division of United States Steel Corporation, Fairfield, Alabama, was five years old when, armed with a toy pick and shovel, he became a coal miner. His diggings were in a six-inch seam outcrop in the family back yard. As small boys will, he plied his father with questions concerning the coal and how it got there. The answers, careful and patient explanations of geology, developed an interest in mining which has remained with Mr. Kirk throughout his life.

Born in Luthersburg, Pennsylvania, Ralph attended Luthersburg Elementary School and Brown Preparatory School in Philadelphia. In 1913, he was graduated from Pennsylvania State College, with a Bachelor of Science degree in mining engineering.

At Penn State, he was elected to Tau Beta Pi, Phi Kappa Phi, and Scabbard and Blade, honorary engineering scholastic, and military fraternities, respectively.

During his high school and college years, Ralph gained valuable experience in his profession by spending his summer vacations at work in and around coal mines. Upon graduation from Penn State, he went to work with a construction company. Within a few months, he left the construction business to return to the mining industry, as assistant to the chief engineer of the Bessemer Coke Company. From 1914 to 1916, he was superintendent of the Luzerne Coal and Coke Company's mines. In June, 1916, he first became associated with United States Steel Corporation when he accepted the position of assistant superintendent of Colonial Three and Four and Bridgeport Mines of H. C. Frick Coke Company, at Scottdale, Pennsylvania.

During World War I, Ralph Kirk volunteered for duty with the United States Army and was assigned to officers training camp at Fort Oglethorpe, Georgia. Later, he served as a captain in the 50th Infantry Regiment.

Returning to civilian life in 1918, Mr. Kirk rejoined H. C. Frick Coke Company and was superintendent of its various mining properties until 1930. In the ensuing six years, he was associated with The Philadelphia and Reading Coal and Iron Company: first as general superintendent of the Mahonoy Division mines; later, as company safety director.

In 1936, Mr. Kirk came to Alabama to resume his association with United States Steel Corporation as general superintendent of coal mines for its Tennessee Coal & Iron Division. Under his direction, TCI's coal mines were extensively mechanized and modernized, and developed to a position of leadership in the bituminous-coal industry.

In 1943, Mr. Kirk was promoted to the position of manager of raw materials, with responsibility for the production of iron ore, coal, limestone, and dolomite for use in TCI's manufacturing plants. Nine years later, the corporation's zinc mining operations in Tennessee were added to the Raw Materials Division and placed under his general supervision.

Mr. Kirk is 1953 national chairman of the Coal Division of the American Institute of Mining and Metallurgical Engineers. He is also vice chairman of the Mining Branch Council, a national director elect, and an executive committeeman elect of the Mineral Industries Education Division of that organization. His other engineering affiliations include the Coal Division Advisory Board and Old Timers Club (membership limited to thirty) of the American Mining Congress; the Coal Mining Institute of America; the American Zinc Institute; the American Ordnance Association; and the Engineers Club of Birmingham, Alabama. He is also a member of the Alabama State Chamber of Commerce, the Downtown Club of Birmingham, the Country Club of Birmingham, the Kiwanis Club, and the American Legion.

Ralph Emerson Kirk married the former Katherine Hayes Willard; they have three daughters.

Hunting and golfing are Mr. Kirk's major hobbies. Despite his claims that both sports are becoming too strenuous for him, he indulges in them whenever his many occupational and civic duties can spare him.

BE OD TO YO

THE STORY OF

TCI RAW MATERIALS

IRON ORE · COAL · LIMESTONE · DOLOMITE and EXPLOSIVES

Within a compact area of a few square miles in Alabama's Birmingham district, the Tennessee Coal & Iron Division of United States Steel Corporation mines and quarries huge quantities of iron ore, coal, limestone, and dolomite to maintain a rated mill capacity of 3,831,000 tons of ingots a year for the production of 100 marketable items of steel

THE Birmingham district of Alabama has been described as a geologist's paradise. Rich in mineral resources, the district is one of a few places in the world where all the major raw materials for the manufacture of iron and steel are located within a compact area of a few square miles. As far as can be determined, it is the only location where large-scale advantage has been taken of such favorable geologic conditions.

Hematite in large quantities outcrops at the crest of Red Mountain, southwest of the Birmingham business district. This is the southward extremity of the Clinton formation, which parallels the Appalachian Range, and is the largest easily workable deposit in the South. In the other direction from Birmingham lies the rich Warrior Coal Basin, from which are mined vast quantities of high-quality coking coal. Fluxing stone, both limestone and dolomite, abounds throughout the area. Limestone deposits lying in strata above the hematite vein are readily accessible. Dolomite lies near the surface and is readily accessible in open-quarrying operations.

All of these minerals – iron ore, coal, and fluxing stone – are brought together at the manufacturing plants of the Tennessee Coal & Iron Division of the United States Steel Corporation, which occupy a strategic position in Opossum Valley, almost exactly centered between the various deposits.

The Tennessee Coal & Iron Division, or TCI as it is generally known, is by far the largest steel producer in the Birmingham district. A fully integrated operation, with its own mining, smelting, and rolling facilities, it produces approximately 100 marketable items of steel from the district's raw materials. It has a rated plant capacity of more than 3,831,000 net tons of ingots a year.

TCI had its origin in the Cumberland Mountains of Tennessee, more than a century ago, when it was organized as the Sewanee Mining Company. At first, its properties consisted entirely of one small coal mine. After expanding to include the production of coke and pig iron, the company, in 1886, then known as the Tennessee Coal, Iron and Railroad Company, moved into the Birmingham district. Here, it acquired the mining and manufacturing facilities of various smaller companies and welded them into one complete operation. The company was acquired by the United States Steel Corporation in 1907.

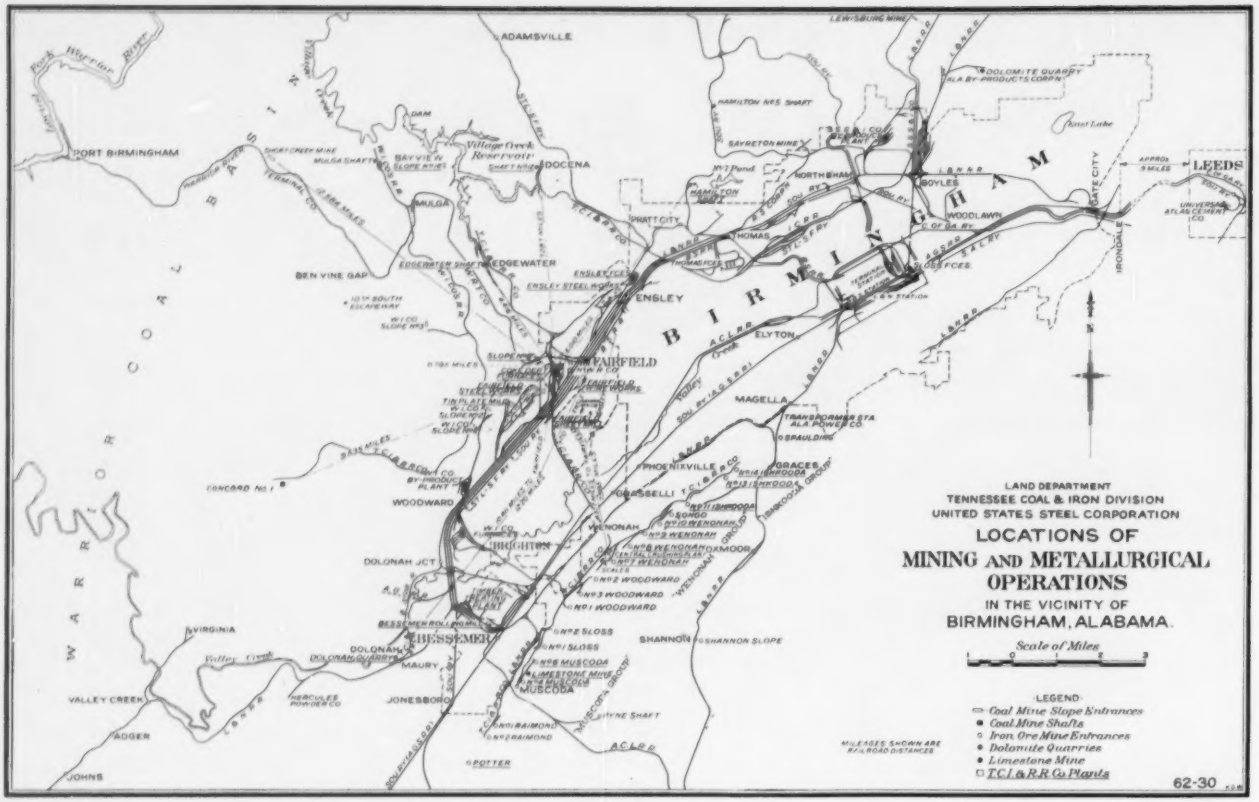
TCI's mining operations are organized as the Raw Materials Division of the Operating Department. Further subdivisions in the Birmingham district include the Ore Mines and Quarries Works, encompassing the production and processing of iron ore, limestone, and dolomite, and the Coal Mines Works.

HEMATITE MINES

The ore-mining operations are conducted at Muscoda and Wenonah, on Red Mountain. Six hematite mines are now in production, one at Muscoda and five at Wenonah. These mines pierce the outcrop into the Big Seam, which extends in workable condition for some 15 miles along the outcrop. The seam ranges in thickness from 10 to 16 ft. and is divided by a parting varying in thickness from knife-edge to 30 in. or more. Mining is conducted principally in the upper bench, although various proportions of the lower bench are also utilized at some of the mines. At present, the iron content of typical ore ranges from 37 to 38 per cent.

From the time TCI moved into the Birmingham district, it has maintained a policy of steady improvement of mining facilities and methods. From the old hand-mining methods of half a century ago, it has advanced in technique to the point where underground operations are now on a highly mechanized basis. As late as February 1, 1953, the last drag-stope operation at the ore mines was replaced by trackless mining devices. Now 100 per cent mechanized, the mines are equipped with self-propelled drill jumbos, crawler-mounted loaders, rubber-tired shuttle cars, and the accessory equipment for the mining of the heavy, abrasive iron ore.

The panel system of mining is employed. Rooms are driven from a panel air course at an angle so that the grades will be planned for about 5 per cent, and are halted at a distance of about 350 ft. Breaks or cross-cuts in the pillars between rooms are made at regular intervals to provide access for mo-



bile equipment and to effect ventilation.

There are 20 panels in operation at the six ore mines. One of every five panels is used as a spare. The production and the development crews each work in their designated panel four turns a week and in a spare panel one turn, to allow weekly preventive maintenance to the mobile mining equipment in each panel.

The cycle of mining comprises installing roof support, drilling, blasting, bulldozing, and loading. Trimming of loose ore or rock enters the cycle at all operations except blasting.

Roof Control

Roof bolting is now used for roof support throughout TCI's underground mining operations. In recent years, this method of roof control has largely supplanted the wooden and steel beams ordinarily used in coal and iron ore mines. One of the pioneers in roof bolting in this type of mining, TCI has found that this procedure has many definite advantages over the older method.

Timbers were often knocked out during blasting and were more easily dislodged by rock falls. With the installation of trackless mining equipment, it was found that supporting legs were frequently dislodged during the movement of equipment. Furthermore, it was difficult to provide adequate roof support close to the face. Roof bolting has done much to alleviate these difficulties. The result has been a significant reduction of hazard to employes and in the contamination of ore by falling rock. A considerable saving has been effected in the time required to bar down loose material and clean up nonmetallic rock.

The standard roof bolt used in the ore mines is a round steel rod, approximately an inch in diameter, and varying in length according to roof conditions. It is slotted at one end to admit a wedge ¾ in. thick and 6 in. long, and threaded at the other end. Washer-type square bearing plates or steel channels, depending upon the type of support required, are secured to the bolts to serve as support for the various types of roof strata.

In placing the bolts, holes are drilled up into the roof strata by use of pneumatic equipment. Then bolts are inserted, with wedges in the slotted ends. As the bolts are seated, the wedges are driven into the slots, causing the bolts to expand and grip the sidewalls of the drill holes. Bearing plates or channels are then fitted over the protruding ends and secured by nuts, which are tightened by impact wrench.

Each mechanized mining panel is equipped with an air motor-powered, crawler-mounted roof bolt machine. An adjustable platform, from which the crew drills and sets bolts, is mounted on the machine.

Drilling

After bolts have been set to the working face, the drill crew moves in. The drilling of ore preparatory to blasting is done with self-rotating, percussion-type drills, mounted on carriages. Two drills are mounted on each carriage, or drill jumbo. The drill jumbo is rubber tire-mounted. Its motive power is furnished by two air motors.

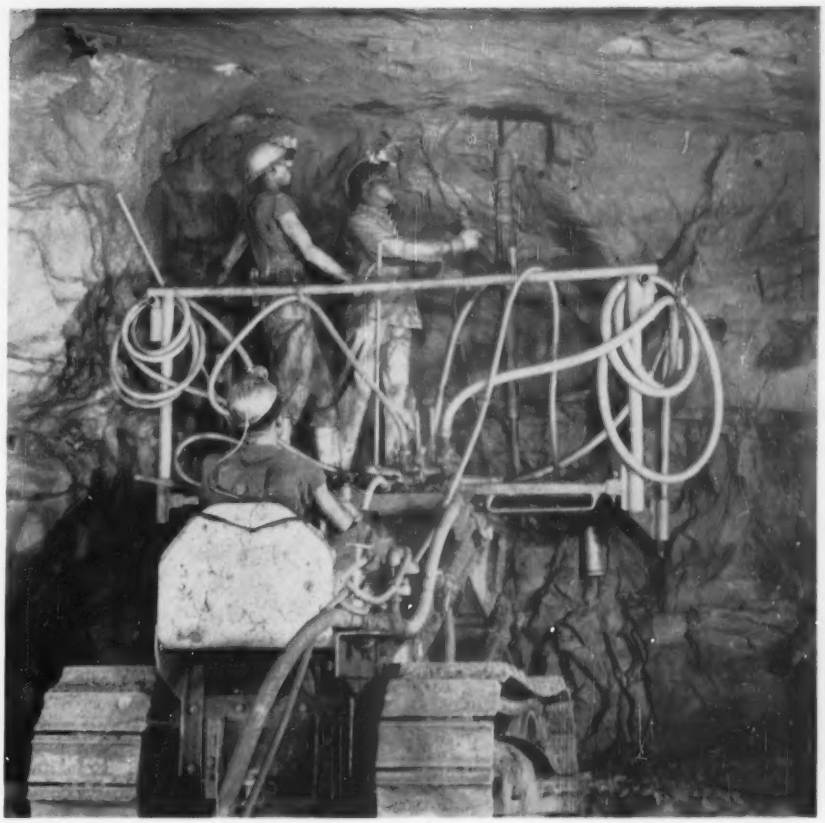
Standard procedure is to drill 30 blast holes, angled from the walls toward the center. Additional holes, up to 40, may be drilled, depending upon roof height. The angles of the holes

may be set by a steel-bar template or by quadrant gauges on the jib arms of the jumbo.

Blasting

With drilling completed, the jumbo moves to another working face, and explosives are loaded into the drill holes. From 258 to 304 cartridges of dynamite may be loaded, depending upon the number of holes in the round. The detonators used are No. 6 blasting caps attached to semisolid-core safety fuse, cut in 10-ft. lengths. An average of 6.85-ft. advance for each blast is consistently maintained.

Rigid safety regulations govern the handling of explosives. Mines having closely set panels use a centrally located magazine for the storage of dynamite. The magazines are of concrete block and wooden floor construction. Proper ventilation and a protected lighting system are provided. Mines with divergent working sections use a small, portable magazine of wooden construction located within each panel, in an area well removed from present mining. All magazines are kept locked and are entered only by authorized personnel. Dynamite cartridges are carried in rubberized canvas packsacks from the magazines to the blasting sites. Detonator assemblies are carried in a circular cardboard



ROOF SUPPORT – ORE MINES: Roof bolting is now used for roof support throughout TCI's underground mining operations. In the ore mines, each mechanized panel is equipped with an air motor-powered, crawler-mounted machine with an adjustable platform from which the crew drills holes and sets round steel bolts into the roof. The result has been a significant reduction of hazard to underground employes and in the contamination of ore by falling rock.

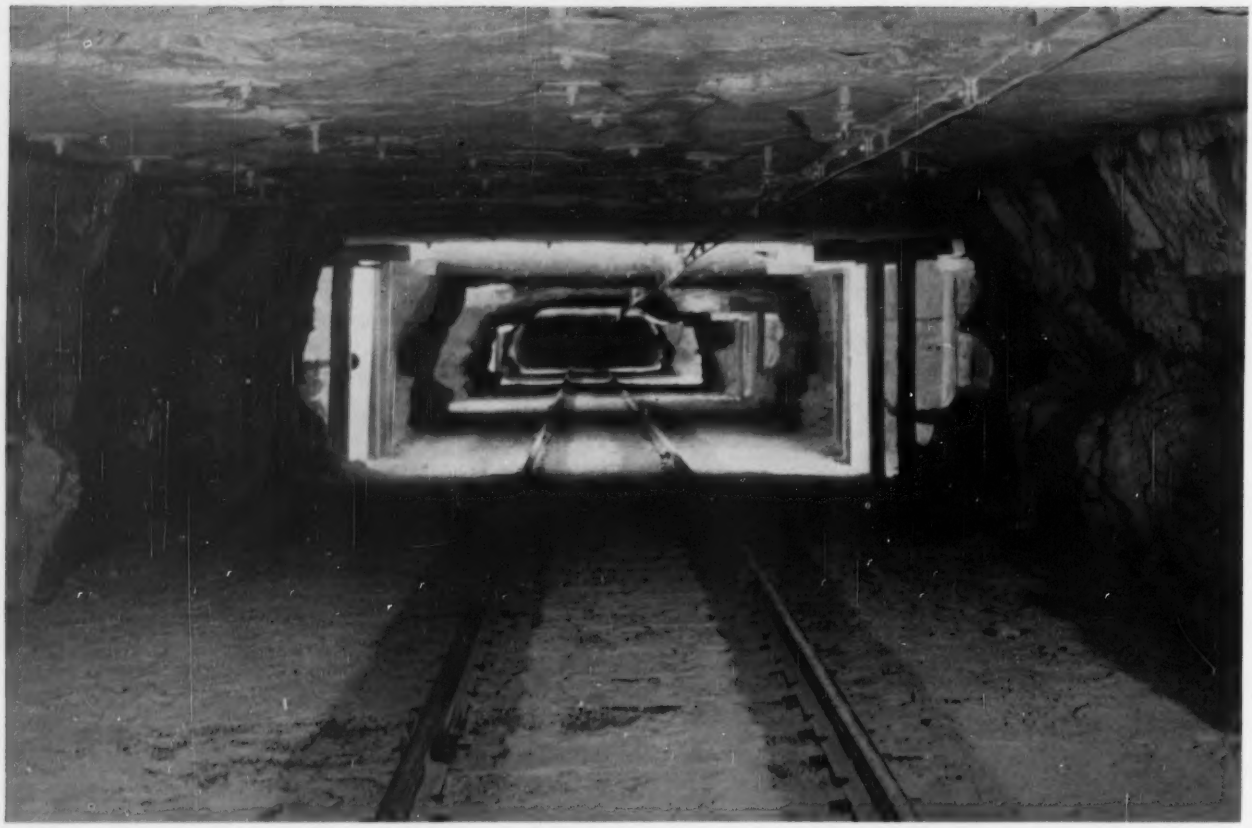
DRILLING IN THE ORE: After bolts have been set into the roof of a working place, the drill crew moves in. Holes for blasting are drilled into the ore with two self-rotating, percussion-type drills mounted on a mobile jumbo. Motive power for the jumbo is supplied by two air motors.

LOADING BLAST HOLES: Following the drilling of a round of 30 to 40 blast holes into the ore, they are loaded with from 258 to 304 cartridges of dynamite, depending upon the number of holes in a round. The charge of explosives in each drill hole is primed with a No. 6 blasting cap attached to a 10-ft. length of semisolid-core safety fuse.

RECOVERING BLASTED ORE: The recovery of blasted ore is accomplished with a caterpillar-mounted, continuous-type loading machine specifically designed for loading ore. Two gathering arms at the head of the loading machine move the ore into a conveyor which passes it back across a boom into a shuttle car of 14-ton capacity.

UNLOADING RAMP: Two shuttle cars are used with each loading machine to transport the ore from a working face to unloading ramps at the panel haulage. At the unloading ramps, the ore is removed from the shuttle cars by self-contained drag conveyors and deposited direct into rail-mounted mine cars of 10-ton capacity.

EN ROUTE TO THE SURFACE: Ore is dumped from mine cars into storage pockets and, subsequently, into measuring pans of 15-ton capacity. Skips are spotted beneath a pan, the doors are opened, and the skips loaded. At the hoisting signal, the loaded skips are hoisted up an incline to the surface and their contents dumped into a tipple bin.



MODERN HAULAGEWAYS: Underground haulageways in TCI mines in the Birmingham district are designed and constructed on modern engineering principles to provide for safe and rapid transportation. The tracks are made up of 90-lb. rails laid on creosoted ties ballasted with slag.

container from a centrally located cap-and-fuse preparing station to each operating panel.

Loading and Haulage

After blasting, recovery of the broken ore is accomplished by a caterpillar-mounted, continuous-type loading machine specifically designed for loading ore. Two gathering arms at the head of the machine move the ore onto a conveyor which, in turn, passes it back across a boom into a pneumatic-tired shuttle car. The boom, an integral part of the loader, can be moved either horizontally or vertically to simplify the positioning of both the loader and the shuttle car. The loader head also can be moved either horizontally or vertically.

Two shuttle cars, each of 14-ton capacity, are used with each loader to transport the blasted ore from the working face to unloading ramps at the panel haulage. At the ramps, the ore is removed from the shuttle cars by means of self-contained drag conveyors and is deposited direct into rail-mounted mine cars. As the 10-ton steel mine cars are loaded, they are moved to the nearest sidetrack in the panel and made into trips for mainline locomotives. When a trip of ore has been loaded, a centrally located dispatcher is notified. He sends a 25-ton electric mainline locomotive to haul the trip to a storage pocket. As the locomotive picks up a trip, it replaces the loaded mine cars with empties.

The ore is dumped from the mine cars by rotary dumps into storage pockets located over main or auxiliary slopes. Rotary dumps, which handle one car at a time, are located at most mines. At one mine, however, end-dump cars are used, with the ore being dumped into a measuring hopper over the main slope.

Hoisting

The six currently operated ore mines hoist through seven main slopes, which range in length from 5,200 to 6,700 ft. The slope pitch averages about 17 degrees. Three of the mines handle ore on auxiliary underground slopes from which it is transferred to the main outside slopes.

Ore is drawn from the pocket into a measuring pan, each load being approximately 15 tons. As the skip is spotted beneath the pan, the doors are opened and the skip is loaded. At the hoisting signal, the loaded skip is hoisted to the surface and dumped into a tipple bin. Dumping is accomplished by elevation wheels on the rear axle of the skip, allowing the hinged front to swing open.

Ore is drawn from the tipple bin into 70-ton railroad cars, and transported to a central plant for crushing, sizing, and blending.

Hoisting equipment consists of five electric hoists and two steam hoists on the surface for operation of skips on the main slopes, and three electric hoists underground, which operate on auxiliary slopes.

Ventilation and Dust Control

The ore mines are ventilated by four surface fans of the axial flow type, with adjustable pitch propellers, which ex-

haust a total volume of 1,100,000 cu. ft. a minute. In addition to the surface fans, there are 13 booster fans underground. These are easily moved and are maintained quite close to the active area. Their main purpose is to augment and distribute air pressure and to balance major splits.

The air is routed to active workings via the slopes and haulages. Air courses and worked-out areas are used for return air. Intake and return air is separated by concrete block walls. Each panel is allotted a minimum of 25,000 cu. ft. a minute. Overcasts or undercasts are used to pass return air from lower workings over or under the fresh air entering the panel. By these means, doors have been eliminated from haulages.

Centrifugal-type auxiliary fans are used to carry fresh air direct to the working face. These are utilized to blow the fresh air through metal or flexible tubing.

A fourth ventilation shaft has been completed and connections are now being driven to it from the underground workings. Another shaft is being sunk and an additional one is planned. These new shafts are located closer to the active workings.

Adequate ventilation alone is not sufficient to maintain satisfactory atmospheric conditions underground. Therefore, secondary features of dust control are widely practiced. Each loading unit is equipped with four fixed water sprays and a fifth spray with a trigger-type valve to be used at the discretion of the operator. All drilling is done wet. Main haulages are wet down at periodic intervals. Each mine is equipped with a mobile 800-gal. water tank, with pump and spray manifold incorporated, which may be used for wetting the haulage or for fire fighting, if necessary.

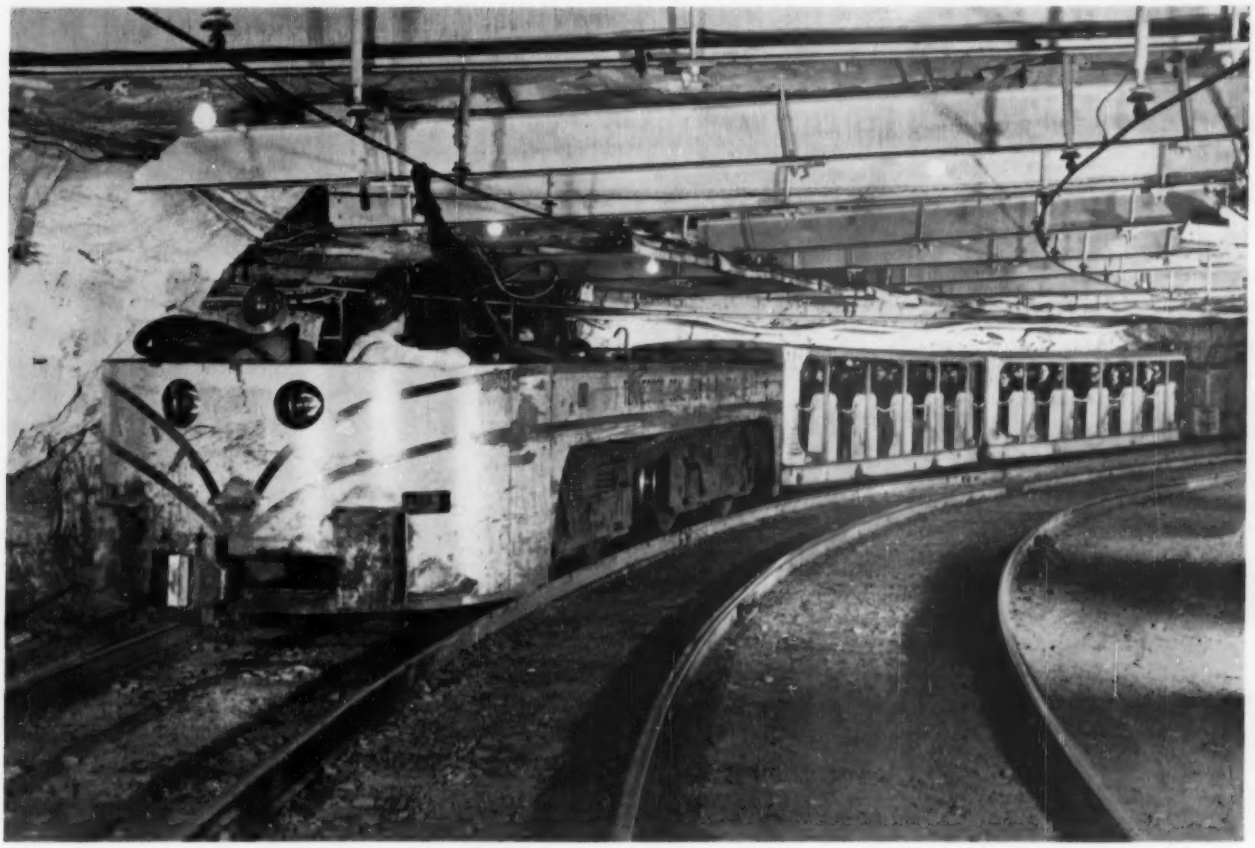
There is a four-hour interval between shifts and all blasting is done at the end of the shift. Fans are in continuous service, and the ventilation is such that all smoke fumes and dust from blasting have been removed before the oncoming shift enters a working place.

Education in ventilation and dust control has been incorporated in the supervisory training program. It is felt that this policy has paid off in better utilization of the ventilation and dust-control features of the underground operations.

Maintenance of Equipment

In mechanized mining, the proper maintenance of equipment is essential to efficiency of operation. Extensive maintenance and repair facilities are available, both underground and on the surface, in order to keep all equipment in first-class condition. Underground equipment includes motor pits for locomotive repair and maintenance, shops for repair of tram cars, and a shop in each trackless mining section, with necessary tools and spare parts for spot repairs.

Minor maintenance and repairs, lubrication, and inspection are performed by specialized personnel underground. All unit and major



MAN-TRIP CARS: A view of one of the man-trip cars which convey employes to underground working areas in the TCI ore mines. The spick-and-span appearance of the mine and the equipment is indicative of good housekeeping, a "must" at all properties of the Division.

ORE MINERS' SAFETY MEETING: The heart of TCI's safety program is the group meeting held underground each week by the supervisor with his men. The subject matter reviewed is slanted to fit the problems of each man and each crew, with the supervisor guiding the discussions.

overhaul work on equipment is done in the surface shops.

ORE-CONDITIONING PLANT

There is sufficient variance in the metallurgical analysis of mine-run ore from the various mines on Red Mountain to make necessary the use of blending facilities whereby raw material of fairly constant analysis may be delivered to the blast furnace. Blending is accomplished at the Central Ore Conditioning Plant at Wenonah. Here the ore, both local and imported, is crushed, screened, and blended. This not only provides ore of uniform chemical analysis but also allows for the control of the size and the physical characteristics of the raw material. At the plant, the fines are either sintered or briquetted to provide a large amount of void space, which is necessary to the proper functioning of the blast furnaces.

Ore from each mine is accumulated in a storage yard and handled separately through the plant. Seventy-ton railroad cars of ore are emptied into a two-car rotary dump, the ore falling into a two-compartment bin. From the bin, the ore flows across grizzlies which remove the fines and discharge plus 5-in. material into gyratory crushers. The undersize from the grizzlies is directed to belt conveyors where it recombines with the product from the crushers. The recombined ore goes to surge bins from where it is fed to vibrating screens which separate the product larger than 1½ in. from that which is smaller. The larger material then goes to secondary crushers.

Once again, the undersize material from the screens and the oversize which has passed through the crushers are recombined. Taken by belt conveyor to the screening building, the ore is fed into a three-compartment bin. From the bin, the ore is discharged into gas-heated, vibrating screens which separate it into three sizes: coarse, medium, and fines. A ½ per cent sample is automatically taken from each of the three sizes so that each size may be tested for chemical analysis.

From the screening plant, the coarse and medium ores are conveyed to their respective storage silos. There are 48 silos, each having a capacity of 800 tons. Ore from each mine is kept in separate silos so that blending to the desired chemical analysis and size can be effected.

High-grade foreign ores are handled through the plant in the same manner as the local ores; separate silos are provided for their storage.

The 24 silos for each of the coarse and medium ore products are arranged in six groups, with each group of four discharging into a common hopper. Blends of the desired chemical analysis are obtained by varying the speed of the conveyor belts by which the ore is discharged from the hoppers.

The blended products are collected and transferred by belt conveyor to the loading bins. In this transfer, each product is weighed and a sample is automatically taken for a check on the chemical analysis of the blend. The blended products are loaded into railroad cars and shipped to the blast furnaces.

Sintering

The physical properties of ore fines render them unsuitable for use in the blast furnaces. The small particles would not permit the necessary air space for smelting; furthermore, much of this material would be blown from the furnace stack by the tremendous blasts of air which are introduced through the tuyeres near the furnace hearths. At the Central Ore Conditioning Plant, two methods are employed for agglomerating this material, or fusing it into pieces sufficiently large for use in the furnaces. One method is sintering, whereby fusion is accomplished by the application of heat. The other is briquetting, through which the ore is mixed with a binder and pressed to form egg-shaped pieces, which are called briquettes.

Fines from the various ore mines are fed from the screening plant into bins in the sintering plant, the material from each mine being stored separately. Bins are also provided for coke, flue dust, and other materials used in the agglomerating processes.

In sintering, flue dust, which is principally unsmelted fine ore recovered from the blast furnaces, is added to the fines recovered during crushing and screening. Coke supplies the heat necessary for fusion. The materials are fed from the bins by proportional feeders to conveyor belts. As the blend is conveyed to the sintering plant, hot sinter fines which have passed through the sintering beds are added to the top of the material on the conveyor belts. The sinter fines help to maintain the porosity of the sintering beds.

The entire mixture is discharged into a pug mill for thorough mixing and then split by a revolving distributor into three equal parts, one for each of the three sintering machines. The material for each sintering machine then passes into a revolving drum-type pug mill where the necessary amount of water is added and the materials are again mixed. The feed then moves to the sintering machines where a gas flame ignites the combustible materials in the mixture. Burning is accelerated by a down draft of air drawn through the sintering bed by a centrifugal fan. As the material advances slowly on the continuously moving sintering bed, the ore fines are fused. The sinter discharges the fused ore from the machines across stationary grizzlies where the return fines are removed, after which the ore goes direct to railroad cars. Water sprays located in the chutes and over the tracks are used for cooling the sinter.

Briquetting

At present, briquetting is being done intermittently, on an experimental basis. In this type of agglomeration, Portland cement is used as a binder. Blended ore fines and a small quantity of cement are mixed, and moisture is added in a pug mill. The mixture is passed between briquetting rolls which contain corresponding indentations for the formation of briquettes. The briquettes pass across a screen before being loaded into railroad cars. A shed is provided over the loading tracks so that the briquettes can be stored under cover for 24 hours.

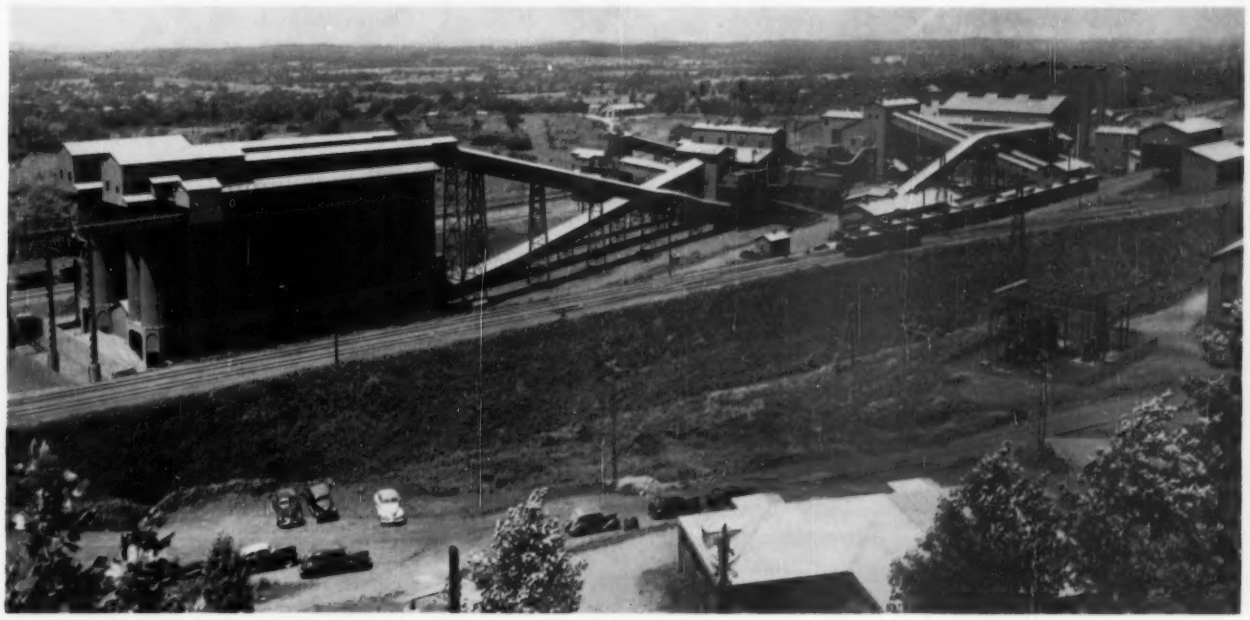
LIMESTONE MINE

Limestone is used in comparatively small quantities at the blast furnaces. Its principal use is as a flux in the open-hearth process of steel manufacture. All of TCI's requirements are supplied by the No. 5 Limestone Mine at Muscoda. The limestone is mined from a deposit lying above the iron ore strata and is brought to the surface through a slope of the No. 5 Iron Ore Mine, no longer being worked for hematite.

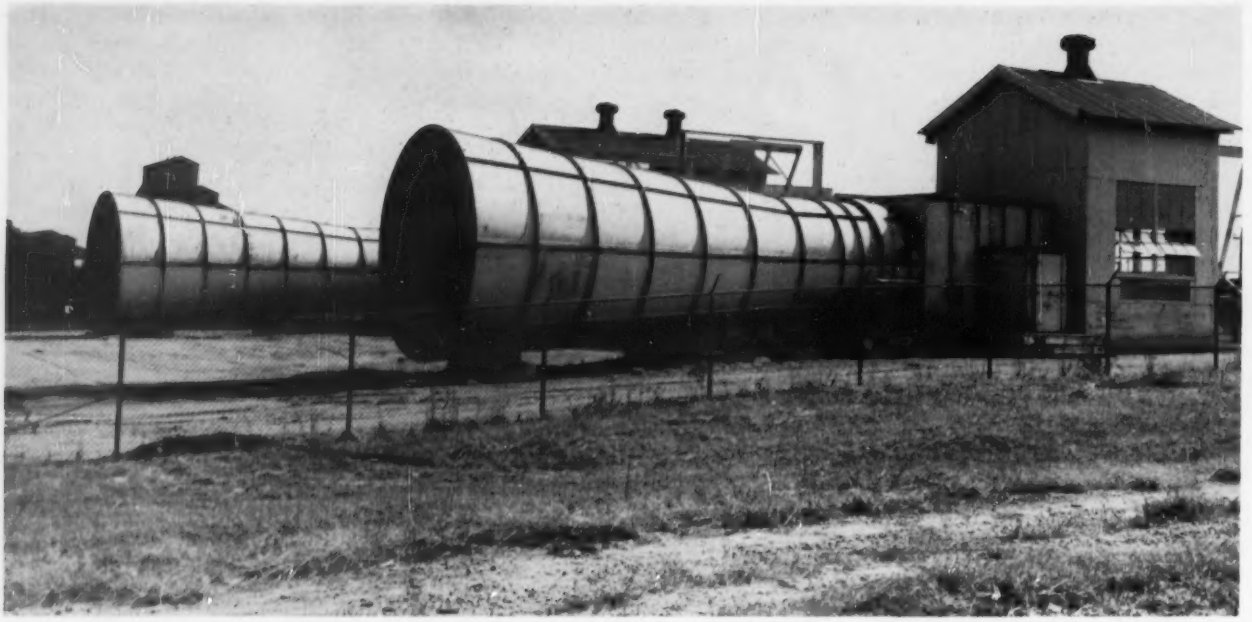
The mining practice at No. 5 Limestone Mine varies within the mine and consists of three types: panel mining, open stoping, and haulageway development. A panel consists of a haulageway and an air course driven approximately along the strike, with rooms turned obliquely up the dip from the air course. It is similar to the mechanized panels operated in the ore mine. The roof formation is sufficiently strong to require no timbering; therefore, the principal operations are drilling, blasting, and loading. Currently, one panel is in operation.

Rooms are driven 25 ft. wide in the lower bed of limestone. The middle bench is taken down by back-stoping but is carried about 25 ft. back of the face during driving. The upper bench is not drilled until the room is completed, after which it is drilled and blasted from the room limit backward to the air course.

Two drill jumbos are in use in the panel. The first is rubber mounted and the other is a converted drill-mounted half-track. A 29-hole, 60-degree single vee round is drilled into each face, with



ORE CONDITIONING: Mine-run ore from the various mines on Red Mountain is crushed, screened, and blended in the Central Ore Conditioning Plant at Wenonah. This provides ore of uniform chemical analysis and controls the size and physical characteristics of the raw material.



DUAL-FAN INSTALLATION: The fan at right, powered by a 600-hp. motor, delivers 500,000 c.f.m. of air at 5-in. water gauge. The fan at left, powered with an internal combustion engine, automatically starts and carries the load in the event of an electric power failure.

OVERHAULING EQUIPMENT: At least once a year, all major sectional equipment used underground is brought to the shops on the surface for complete overhaul jobs. Such preventive maintenance insures long periods of operation, with a minimum of equipment "down time."

templates being used to align the drills. The average advance from a blast is 8 ft.

The blast holes are loaded with cartridges of 60 per cent gelatin dynamite. Prepared bags of clay stemming are utilized for tamping the dynamite charge in each blast hole. Detonation is accomplished by means of electric blasting caps, connected to a permanent blasting circuit. Blasts in all faces are fired at once, at the end of a shift.

An electrically driven, crawler-type loader similar to the type employed in the ore mines is used for recovering the blasted limestone. The loader is serviced by two Diesel shuttle cars which dump from a ramp into mine cars. The Diesel engines are equipped with exhaust gas scrubbers in which sodium sulphite and hydroquinone are used to remove the fumes.

At present, three headings are operating with drag scrapers.

Haulageways and panels are developed with two track-mounted shovel loaders. The loaders discharge by conveyor direct into 5-ton mine cars which are switched by a 10-ton locomotive. The drilling is done from a rubber-tired drill jumbo identical with that used in panel mining.

Haulage in each heading is independent of other working areas and is directly accessible to the hoisting slope. The broken stone is loaded by shuttle car or drag into 5-ton end-dump cars which are made up into trams of six or eight cars. The trams are pulled by 10-ton and 20-ton locomotives. The loaded cars of stone are dumped by an air-operated end-dump into skips at the slope, each of which has a capacity of one car.

The limestone mine is ventilated by the same fan which provides air for No. 6 Iron Ore Mine. In most aspects, ventilation and dust control are similar to those in the ore mines.

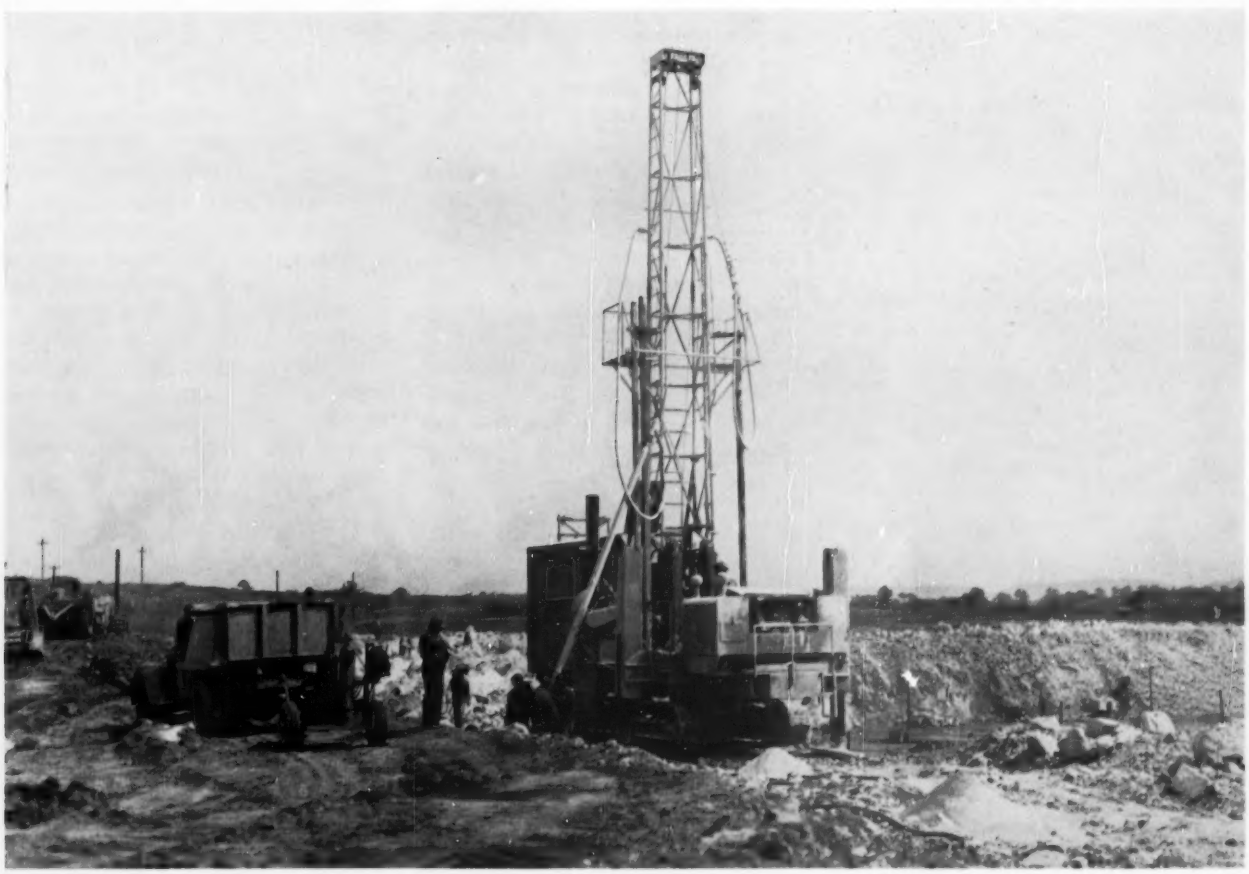
Surface Processing

After the limestone is dumped by the skip cars into a surge bin at the surface, the stone is fed into a jaw crusher with a 7-in. setting. A slowly moving conveyor belt serves as a picking table in moving the crusher product to a vibrating screen with 5-in.-square openings. The plus 5-in. material moves from the screen direct to railroad cars for shipment to the blast furnaces. The screen undersize discharges into a secondary cone crusher.

The secondary product is wet-screened to separate the plus ¾-in. material from the smaller sizes. The plus ¾-in. stone is again wet-screened. All material which will not pass through a 10-mesh screen is shipped to the open-hearth furnaces. The screen underflow solids are pumped to a settling tank where the solids settle out and the clarified water overflows and returns to the plant. The cone underflow is flumed to a tailings pond.

DOLOMITE QUARRY

Dolomite, used as a fluxing stone in the blast furnaces, is obtained from



QUARRY DRILLING: After the overburden has been removed, the drilling of vertical blast holes along the rim of the dolomite quarry face, which varies from 65 to 70 ft. high, is accomplished with crawler-mounted, electric-powered rotary drill machines. All drilling is done dry.

QUARRY BLASTING: The explosives used in primary blasts in the quarry at Dolonah are standard-size cartridges of Gelamite and Hercomite. The dynamite charges are detonated with Primacord attached to delay electric blasting caps, which, in turn, are connected to a permanent power circuit. Blasts are fired once or twice during each working day. Excellent fragmentation of the dolomite is consistently obtained.

the Dolonah Dolomite Quarry. This quarry, covering an area of almost 100 acres, is operated in the Ketona formation. The thickness of the dolomite in the currently developed area varies from 110 to 400 ft.

The overburden, averaging 15 ft. in thickness, is removed by the use of bulldozers, pans, draglines, and trucks. Drilling holes for blasting in the quarry face, which varies in height from 65 to 70 ft., is accomplished with crawler-mounted rotary drills. The drills are electric-powered machines with an air compressor and a dust collector mounted on each unit. Blast holes are drilled vertically behind the face. The drilling is done dry.

The explosives used for blasting are Gelamite® and Hercomite® in standard-size cartridges. Detonation of the explosives charges is accomplished by the use of Primacord* attached to delay electric blasting caps, with the cap leg wires connected to a permanent circuit. Blasts are fired once or twice during each working day.

Loading equipment at the quarry consists of two 2½ to 3-cu. yd. electric crawler shovels and a 1½-cu. yd. Diesel shovel which is used as a standby and to augment the capacity of the electric shovels. The two electric shovels, working two shifts a day, have a combined loading capacity of 2,500 tons of broken dolomite a day.

*Reg. U. S. Pat. Off. by The Ensign-Bickford Company.

Crushing and Sizing

The shovels load direct into six 12-cu. yd., side-dump Diesel trucks, for hauling across the quarry floor to a dumping station. At the dumping station, the dolomite is fed into skips which carry it up an incline, approximately 375 ft., and deposit it into a primary gyratory crusher. The crusher product is wet-screened, and plus 4-in. stone goes to a secondary crusher. The undersize is again screened on ½-in.-square opening screen cloth. The secondary product passes to an identical screen. Plus ½-in. material discharges into railroad cars for shipment to the blast furnaces. The undersize from both screens is once again rescreened wet, with plus 0.12-in. material being loaded for shipment to the open-hearth furnaces. The underflow, consisting of fine-size solids and water, is pumped from the screens to a tailings pond for disposal.

SAFETY PROGRAM

As attested by the many high awards which have been earned by the various units of the Ore Mines and Quarries Works, paramount importance within the works is placed on safety. Owing to a comprehensive safety program, accident-frequency and accident-severity rates have decreased steadily in the past five years. The frequency rate of 7.68 for the year 1952 showed a 60 per cent reduction from that of 1947; the severity rate of 4.43 showed a 46 per cent reduction. No. 5 Limestone Mine has been the recipient of the Sentinels of Safety trophy five times. The Dolonah Dolomite Quarry has been awarded the coveted bronze trophy four times.

These accomplishments may be attributed mainly to the adoption of roof bolting, the mechanized mining operations, an improved safety-training program, and a more alert and effective method of supervision.

Safety training begins when an applicant is accepted for employment and continues as long as he is employed. The new employe receives an illustrated booklet which outlines the responsibility of employe and management with regard to safety. Safe practices are illustrated by photographs and sketches; correct procedure instructions are itemized under each safety practice.

The new employe is at once given a short talk on safety by the mine foreman, who initials a safety instruction sheet. This serves as a check sheet to assure proper instruction and as a record that such instruction has been given. Not later than 15 days after the date of employment, the check sheet is again initialed by supervisors and the safety inspector, after which it becomes a part of the employe's permanent record. Crew leaders, foremen, and safety inspectors work together to develop good safety habits in the new employes.

The continuing safety program for all employes consists of short weekly huddle meetings; monthly meetings conducted in underground and surface safety halls under the direction of mine officials and safety inspectors; the issuance of safe-practice cards dealing with specific hazards; and a quarterly publication, *The Ore Miner*, which deals chiefly with safety, and which is mailed to the employe's home. In addition, safety placards are posted weekly. Safety reminders entitled "Safety Reminder of the Day" are posted daily on a bulletin board located at each mine portal. First-aid training is given to all employes. Supervisory safety training is given to all supervisors at monthly meetings. Materials used at these meetings, conducted by the Safety Department, consist of literature and films furnished by the National Safety Council, which are applicable to supervisory training. Reviews of company safety standards and state metal-mine codes are a regular part of the program.

Hard hats, safety-toe shoes, and goggles are standard protective equipment. The goggles are furnished by the company. The wearing of goggles is required whenever there is a hazard from flying objects.

Since haulage accidents constitute about 20 per cent of the total disabling accidents in the ore mines, much emphasis is placed on this phase of safety. In recent years, many improvements have been made in the physical condition of haulageways and equipment, and rules governing the safe operation of equipment have been tightened.

Handling Explosives

The use of large quantities of explosives requires rigid regulations in their handling, in order to minimize the hazard. Great care is devoted to the proper storage and handling of dynamite and detonators. Only properly qualified and thoroughly trained personnel are permitted to handle explosives and blasting supplies.

Roof bolting, discussed elsewhere in this article, has resulted in a decrease of from 20 per cent of the total disabling accidents resulting from rock falls in 1947, to 12 per cent of the total in 1952. Since the inauguration of roof bolting in 1948, there have been no fatalities as a result of rock falls.

All accidents, regardless of severity, are investigated. Disabling accidents are looked into by a committee composed of the superintendent, chief mine inspector, local mine inspector, mine captain, mine foreman, assistant mine foreman in the area, and witnesses of the accidents.

All nondisabling and near accidents are investigated by the supervisor, who fills out a standard form report of each accident and sends it to the local superintendent's office, with the supervisor's recommendations for the prevention of similar accidents.

A monthly booklet, describing all disabling injuries for the previous month and containing statistics showing the accident standing of each supervisor, is issued to mine captains, mine foremen, and assistant mine foremen in underground operations.

COAL MINES WORKS

All coke used in the blast furnaces of the Tennessee Coal & Iron Division is made from coal taken from the Division's five coal mines in the Warrior Coal Basin, located from 4½ to 12½ miles by rail from the coke plant at Fairfield Steel Works.

The principal coking coal seams in the field are the Pratt and the Mary Lee. Operations in the Docena, Edgewater, and Short Creek Coal Mines are in the Pratt Seam, while Hamilton Coal Mine produces from the Mary Lee Seam. The newest mine, Concord, operates in the American Seam, a part of the Pratt Group.

The height of the seams being worked, including partings, ranges from 34 to 97 in. The coal is a moderately hard bituminous, except that in the American Seam, which is highly fractured and friable. Rock partings within the seams are made up of 2 to 5 in. of "bone" near the top of the seams, and shale or sandy partings 13 to 27 in. above the bottom. Bottom rock is, generally, substantial shale or sandy shale. Roof rock varies from a massive sandstone to a very friable, carbonaceous, and fossiliferous shale. The roof strata are made up of thinly laminated beds of shale interspersed

AFTER A BLAST: A close-up of a 3-cu.-yd. crawler-mounted electric power shovel in the quarry as it loads blasted dolomite into 15-ton trucks for delivery to the dumping station. Working two shifts, two power shovels have a combined loading capacity of 2,500 tons a day.

with sand stringers and fossiliferous bedding planes.

All of TCI's coal mines are fully mechanized and completely equipped with mobile mining equipment, with the exception of Docena where coal is loaded onto shaker conveyors. At the Docena, Edgewater, and Hamilton mines, coal is hoisted to the surface from the underground dump by skips in a vertical shaft. At the Short Creek and Concord mines, rubber conveyor belts are used.

The room-and-pillar method of mining is followed in the Coal Mines Works. The basic phases of the operating cycle in a mobile operation within the works are roof bolting, cutting, drilling, blasting, and loading.

Roof Bolting

Roof bolting in the coal mines is somewhat similar to that in the ore mines, with minor differences in practice being occasioned by dissimilarity of roof conditions. All roof-bolting materials are manufactured at the Division's Fairfield Steel Works.

Roof bolting has resulted in a marked decrease in accidents from roof falls, and has been a main factor in tonnage increases from loading equipment. Research and testing of this method of roof support are part of a continuing program to increase still further the effectiveness of this new type of roof support.

Cutting, Drilling, and Blasting

Before blasting, the face is either undercut, centercut, or overcut by a caterpillar or tire-mounted mining machine equipped with a 9-ft. cutter bar. Slicing out a thin section at the base, the center, or the top of the coal seam assures a more complete fall during blasting operations.

The cutter bars of the mining machines are hollow, permitting piping of water to the cutting head and thus allaying coal dust at its principal source. Before entering a place, all coal-cutting crews make necessary gas and roof tests. Any dangerous conditions are corrected before the machine is trammed to the face. The machine crews also drill the face for blasting.

As the cutting machine crew moves out of a place the shot firer moves in. After making further tests for gas and for roof and rib conditions, he loads the blast holes with charges of permissible powder and makes the wire connections for detonating the blast. All entrances to a place to be blasted either are guarded by company personnel or have prominently displayed signs reading "Danger – Blasting."

Loading and Haulage

The mobile loaders in the coal mines are of a design similar to those at the ore mines, but with additional features which adapt them especially to coal loading. All of the mobile machines are equipped with spray nozzles on the loading head to allay dust.

Following a blast in a place, the loading crew makes tests for gas and for roof and rib conditions. Frequent tests are made throughout the loading cycle. The loading machine discharges into shuttle cars which, in turn, unload into mine cars. The mine cars are hauled by a car tugger hoist operated by means of a remote control switch placed convenient to the shuttle car operator. When a trip of cars is loaded, a sectional locomotive trams it to a swap-out sidetrack and returns

TAMPING EXPLOSIVES: All blast holes in a working face in the coal mines are thoroughly cleaned with a scraper before they are loaded with charges of permissible powder. After the charge of explosives in each drill hole is in place, the hole is tamped to the collar with clay or rock dust.

LOADING THE COAL: Following a blast in a room, the broken coal is excavated by caterpillar-mounted loading machines and discharged into shuttle cars which, in turn, unload into mine cars. The excavating machines are equipped with spray nozzles on the loading head to allay dust.

to the loading point with empties. A mainline haulage crew moves the loaded mine cars from the swap-out track to a central dump, from where they are carried to the surface.

Ventilation

All mines are ventilated by either electrically driven centrifugal or propeller-type exhaust fans located on the surface, or by a combination of them. At present, there are five centrifugal and eight propeller fans in operation, with two additional propeller fans under construction. All fans have auxiliary drives and two are dual installations, complete with fans and drives. The fans are on a separate power circuit, independent of the underground circuit, and are automatically operated. In the event of electric power failure, the auxiliary drive automatically starts and continues to operate until the power is restored. Should the auxiliary drive fail to start, a centrally located signal system sounds an alarm and maintenance personnel are sent immediately to correct the trouble.

Should an electric power failure occur at the dual fans, standby fans automatically start and the air is transferred by means of hydraulically operated doors in the fan duct.

All fans are inspected daily and weekly. A special detailed inspection and test is conducted every six months.

All mines are ventilated on the split system, which eliminates the use of ventilating doors. Fresh intake air is supplied to all working sections. Multiple intake and return airways are provided to pass the required volume of air. All haulages within the mines are on fresh intake air.

Overcasts are constructed of prefabricated steel, concrete, and concrete blocks. A short piece of 6-in. pipe with a removable cap is placed in the overcast to permit rock dusting the return airways by high-pressure rock-dusting machines. When an overcast has served its purpose, it can be dismantled and removed to another location.

Ventilation technicians, whose duty it is to measure the volume of air and methane content at the intake, last crosscut, and the return of all splits and working places, are assigned to each mine. Bottle samples of the return air from the various splits are taken for checking with a methane detector. It is required that the ventilation for an entire mine be measured at least once a week. Daily and monthly reports are made by the ventilation technicians.

Dust Control

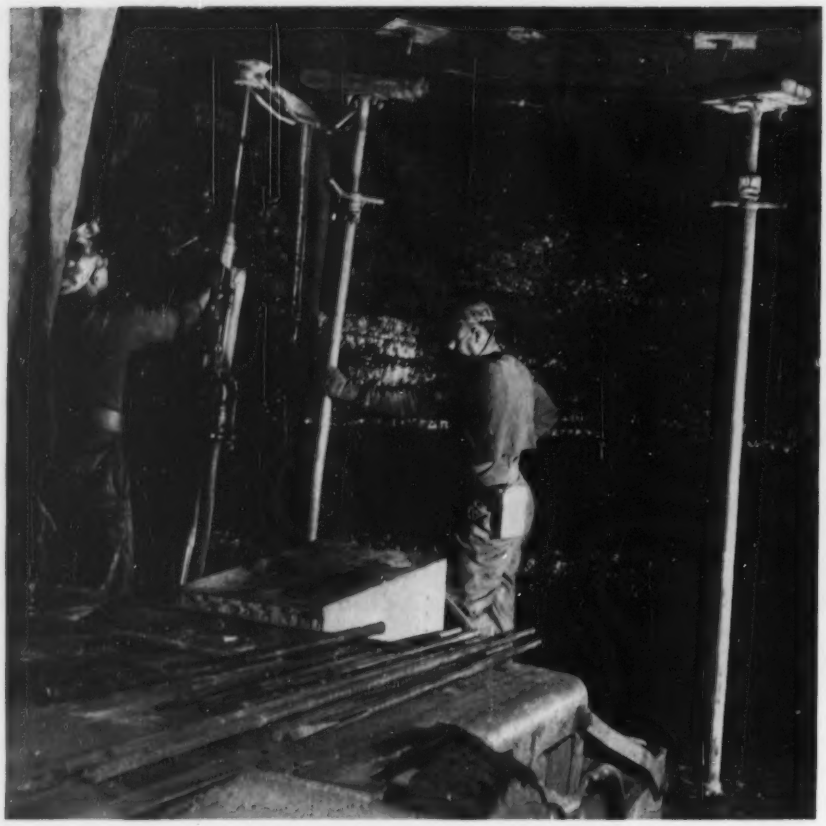
Since air-borne coal dust can serve to propagate even a minor explosion with disastrous results, one of the most important features of safety practice at the coal mines is the prevention of air suspension of coal dust. In addition to the use of water sprays on coal-handling equipment to wet down the material during mining, liberal use is made of pulverized dolomite, marble, and limestone to render coal dust inert.

Rock dust is distributed in all active areas by hand and by electrically operated rock-dusting machines. Active working places are dusted to within 15 ft. of the face. All haulages and return airways are dusted once each month. Rock dust samples are taken throughout the mine by the ventilation technicians and sent to the Coal Mines Laboratory for analyses.

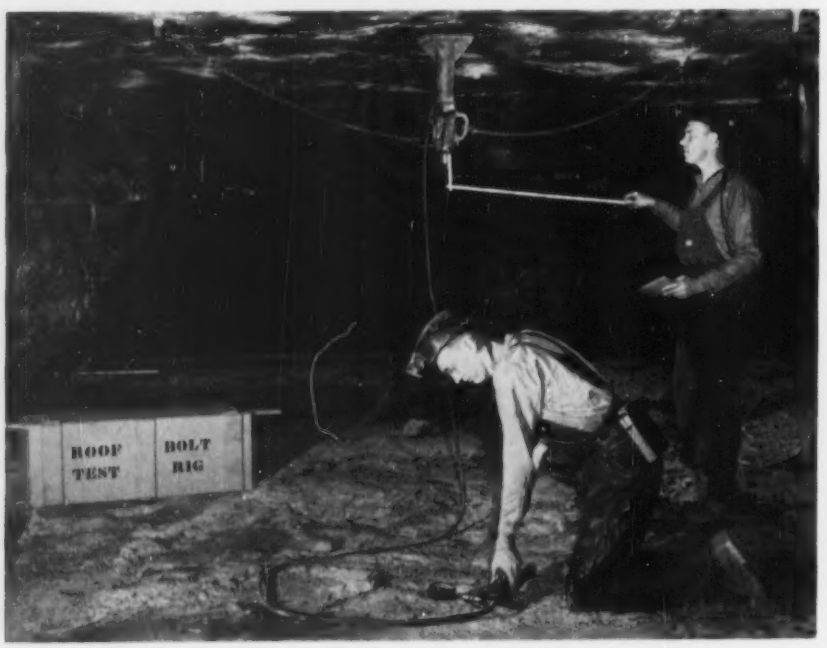
COAL PREPARATION

Because the coal seams in Alabama are interspersed with rock partings, extensive preparation is required before the coal can be used in coke ovens. Proceeding on the theory that coal can be cleaned mechanically on the surface more efficiently than by selective mining underground, TCI has installed coal-preparation plants at each of its coal mines. These vary considerably in equipment and principles of operation. The preparation plant at Concord, the latest installation, is one of the most modern and efficient in America.

At the underground dump station in



ROOF SUPPORT – COAL MINES: To prevent the initial flexure of roofs in TCI's coal mines, steel bolts are installed in the roofs immediately after each place has been cleaned up. The adoption of roof bolting has resulted in a marked decrease in accidents from roof falls and has been a main factor in developing tonnage increases from the loading equipment.



TESTING ROOF BOLTS: A representative number of roof bolts are tested to determine whether they have been properly installed. The test consists of subjecting a load to a bolt until it either slips or breaks. Roof bolting has effected definite savings in time formerly required to bar down loose material and to clean up nonmetallic rock in working places.

the Concord mine, 8-ton mine cars are automatically spotted in a 360-degree revolving two-car rotary dump where run-of-mine coal is discharged into a surge hopper below. From the surge hopper, material is fed through two parallel lines of screening and crushing equipment. The oversize material from screening is fed through a roller crusher and then recombined with the undersize and dropped to a double surge bin.

From the surge bin, the run-of-mine coal is fed onto a "buffer" belt which brings material flow up to the speed of the main slope conveyor which it feeds. The main belt is a 42-inch steel cord conveyor having 2,450-ft. centers. It lifts coal a vertical distance of 730 ft. at a speed of 575 ft. a minute to the crusher building on the surface. Powered by three 300-hp. motors, the buffer belt is designed for a peak load of 1,000 tons an hour.

Passing under a rectangular magnet for the removal of scrap iron, the coal discharges from the buffer belt through a splitter carriage which diverts the flow equally to two parallel lines of equipment. Flow can be diverted to only one line if necessary. Each line consists of a double-deck vibrating screen and a revolving breaker. Oversize product from the 8-in. top deck of the screen is rock and is diverted to a crusher for reduction and disposal as refuse. Oversize from the 2-in.-square opening panels of the bottom deck passes to the breaker. Plus 2-in. material, retained on the 2-in.-round opening perforated shell panels in the breaker, passes through the peripheral discharge at one end and into the crusher previously mentioned. Minus 2-in. by zero undersize from the bottom deck of the vibrating screen and the larger coal from the breaker combine for transfer by belt conveyor to the blending bins.

At this point, approximately 25 per cent of the run-of-mine material has been eliminated as rock.

Blending

The blending section consists of three rows of eight bins each and provides storage capacity for approximately 6,000 tons. The purpose of the bins is to provide surge capacity and uniform quality for size and ash content. They are filled with the minus

2-in. by zero material. Divided into four pockets each for blending, they are filled by a traveling tripper-shuttle unit with the minus 2-in. by zero material, according to a prearranged plan. The blended coal is discharged from the four pockets through a common draw-off gate at each bin to eight variable-speed feeder belts.

Sizing

The feeder belts discharge onto a single 54-in. belt conveyor and thence to a surge bin at the top of the main building. From here the material moves by variable-speed belt and a scraper conveyor for distribution to any combination or all of five double-deck sizing screens, each screen being equipped with water sprays.

Cone Separation

Division is made at 2 by 5/16 in., with the oversize being conveyed to a cone for cleaning in a sand-water medium. After separation in the cone, both the coal and the rock are washed on vibrating screens equipped with sprays for the removal of sand particles. The oversize from the washed coal screens is conveyed to a storage and surge bin over the railroad, and the oversize rock is collected for disposal. All undersize, including sand, is retained in the cone circuit.

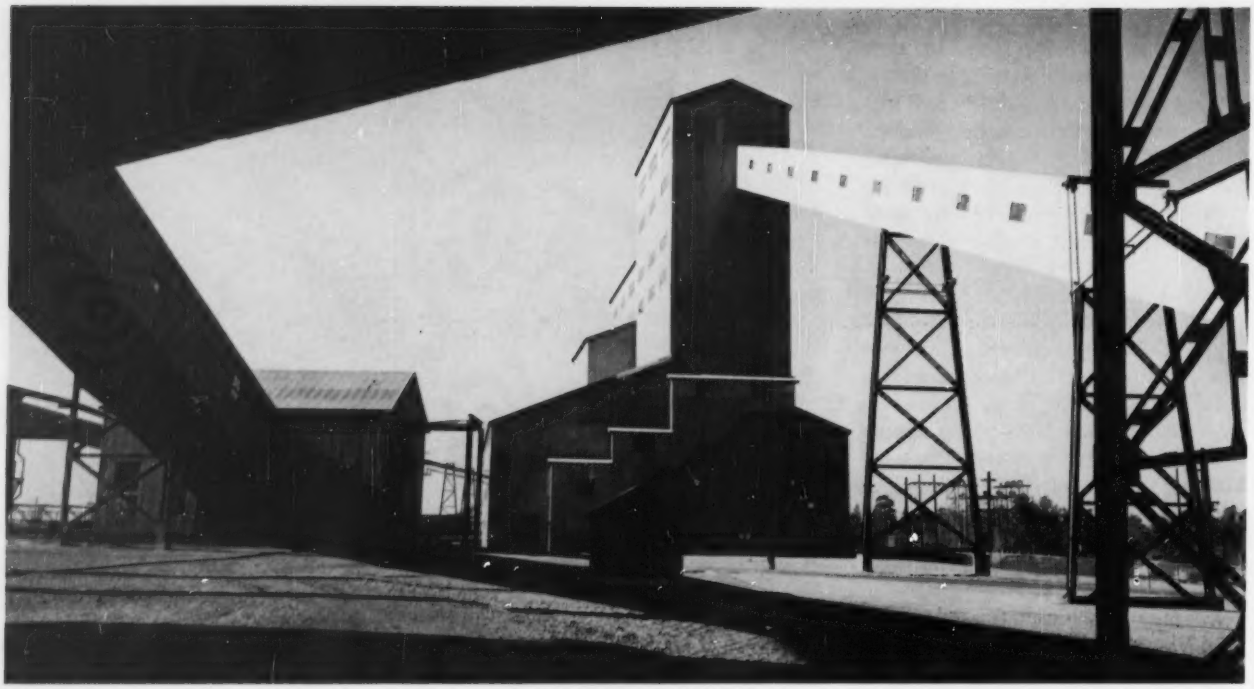
Table Separation

Combined undersize from the five sizing screens preceding the cone flows to a master distributor for quantitative and qualitative division into from two to eight parts, depending on the number of table sections in use. Each part feeds a secondary distributor which divides its feed pulp into either seven or eight parts, depending on the number of tables being operated in that particular section. Each shaker table divides its feed pulp into refuse and washed coal, the refuse being dewatered and discharged into the same disposal bin with the cone refuse. The overflow water, containing coal fines, passes to a thickener for clarification.

Table-washed coal is flumed to dewatering screens equipped with one-half mm. openings. Undersize goes to two hydroseparators where the thickened slurry, containing valuable coal fines, is pumped from the bottom back to the dewatering screens, and is de-

ROOF EXAMINATION: After roof bolts have been installed in a room in a coal mine, the roofs are carefully examined and tested by experienced personnel. Roof tests are made in working places at frequent intervals while mining operations proceed. TCI's policy is to make provision at all times for safe and healthful working conditions of all employes.

TEST FOR GAS: Before any work is started in a room in a coal mine, tests are made with a permissible-flame safety lamp to determine if a place is free of gas. Frequent inspections for the detection of possible gas seepage are part of a continuing safety program.



COAL PREPARATION: TCI has installed coal-preparation plants at each of its coal mines. These vary considerably in equipment and principles of operation. The preparation plant at Concord, shown above, is the latest installation. It is one of the most modern and efficient in America.

posited in a second layer on the oversize coal. Overflow water from the hydroseparators goes to the previously mentioned thickener for further clarification. The thickened slurry withdrawn from the bottom of the thickener is pumped to the dewatering screens to form a third layer, while clarified water is returned to the plant circuit for re-use.

Dewatered washed coal overflowing the dewatering screens discharges to a collecting conveyor and later joins the cone-washed coal for discharge into the loading-out bins above the railroad.

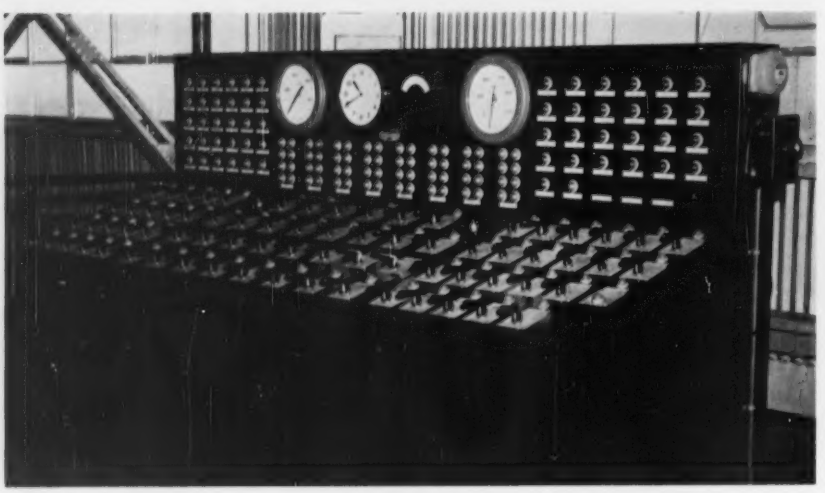
At this final point, approximately 50 per cent of the mine output has been eliminated as refuse.

Maintenance of Equipment

The responsibility for maintenance of equipment at the Coal Mines Works is not limited to maintenance crews. Such responsibility extends to every employe, with each man being trained in the proper use and care of his equipment. Great emphasis is laid upon the preventive maintenance of all operating units, to the end that long periods of operation with a minimum of "down time" may be assured.

Within the coal mines, a repairman is assigned to each operating section on each operating shift, to repair faulty equipment, make preventive inspections, and check for proper lubrication.

A spare section is provided for every eight or fewer operating sections, and approximately each 16 days any particular operating section is shut down for inspection and necessary repairs. Damaged and worn parts, such as transmissions, motors, and clutches, are replaced as unit assemblies, which have been repaired and assembled in surface shops. More extensive repairs, which cannot be handled by the repair crews, are made at underground or surface repair shops. Each coal mine has an underground repair shop equipped with numerous repair facilities and spare parts. Extensive, regularly scheduled overhauls are made at the surface shops. The surface maintenance organization at each mine is also



CONTROL PANEL: All operations in the recently constructed Concord preparation plant are controlled from this panel. Meters indicate the flow of raw coal entering the plant and the tonnage of washed coal en route to railroad cars for delivery to the manufacturing plants.

responsible for the maintenance of all of the surface facilities.

Additionally, there are specialized repair crews, such as a belt-repair crew which makes all major repairs to conveyor belts for all of the coal mines, and an engineering test crew to assist mine personnel in making preventive maintenance on complex electronic and mechanical equipment.

Maintenance in the coal mines is coordinated with numerous other departments in TCI, with the result that more rugged, efficient, and reliable equipment with which to operate the mines is made available.

SAFETY, AND ACCIDENT PREVENTION

A far-reaching and effective safety and accident-prevention program is in effect at the Coal Mines Works. Safe operation of the mines and the surface facilities is considered the responsibility of every employe, from top management to rank-and-file workman. The spirit of cooperation has been so instilled in personnel that everyone considers himself part of a team for the promotion of safety.

It has always been the policy at TCI to provide its employes with modern, safe, and efficient machines, tools, and other facilities so that the desired volume can be produced without risking injury. An adjunct to this program is the provision for safe and healthful working conditions.

The full effect of such a policy, however, can be realized only if men are adequately trained and have developed the proper attitude toward safety. Continual instruction and indoctrination, therefore, are essential.

Safety Meetings

The heart of the safety program is the group safety meeting held each week by the supervisor with his men. Subject matter, prepared by the chief inspector or reviewed by him, is slanted to fit the particular safety problems of each man and each crew. Other than first aid, the same subject is not generally used for all groups. Usually, these group safety meetings are of the conference type, with the foremen guiding the discussions.

It has been the practice for each foreman to set up and present before other foremen at his mine a program outlining what he intends to do to prevent accidents. This practice has produced some extremely good ideas which have been adapted for use in all mines. Its success has encouraged most workmen at some of the mines to present their own programs in writing.

Foremen report to their superintendents all unsafe acts and practices they observe, stating corrective action taken. In considering corrective action, each foreman attempts to probe beyond the apparent reason for the unsafe practice in order to determine the basic cause. Very often it is found that the workman did not know better, had not been thoroughly trained,

COAL MINERS' SAFETY MEETING: A far-reaching and effective accident-prevention program is in effect at the Coal Mines Works. Group safety meetings underground are of the conference type. The spirit of cooperation is so instilled into each workman that he considers himself part of a team for the promotion of accident prevention on the job.

or did not understand, all of which can be corrected by more complete training. Every week, significant unsafe acts and practices at each mine are combined into one report and distributed to all mines for further review.

There is one safety inspector at each mine except Concord, where there are two. The inspectors make very few written reports. Most of their time is occupied with observing various phases of each job or operation, to see that it is performed safely. Where unsafe practices are observed, the safety inspector instructs the man or men on safe procedure. Each of these situations is approached with a helpful rather than a critical attitude.

As a result of the safety program, accident-frequency rates were lower in 1952 than in any previous year. The coal mines as a whole and each mine and department realized rates in 1952 that were lower than in 1951.

There were no fatalities in 1952. Except for the depression year of 1933, when operations were curtailed, this was the first year that the coal mines had operated throughout a calendar year without a fatality.

Short Creek Coal Mine at Adamsville operated throughout 1952, with a total worktime of 588,788 man-hours, without a lost-time accident. On the basis of this record, the mine was awarded THE EXPLOSIVES ENGINEER'S bronze Sentinels of Safety trophy and the Safety flag by the U. S. Bureau of Mines for having had the best record among the 134 underground bituminous-coal mines enrolled in the National Safety Competition of 1952.

THE CHAMPION

By W. H. HOLLIDAY*

There's a guy I know works down the mine,
And a busy fellow he;
He works the morning shift and night,
And the shift which starts at three.

O boy! The job that fellow does!
He's the best man on the hill;
He does more work than Dan and Joe,
And maybe Pete and Bill.

He breaks more rock than Tom and Mike,
Than Dick and Jim and Ed;
Then pick a dozen more or so,
And still he'll be ahead.

He works in drift and stope and rill;
He works in shaft and raise;
He's everywhere at once, that guy,
And nights as well as days.

Strange, too, he never has a lunch;
He never rolls a pill;
His only aim in life, it seems,
Is tearing down the hill.

I see you doubt my word, young man,
Now let me set you right —
The guy I mean's named Gelatin,
And his last name's Dynamite.

*Butte, Montana

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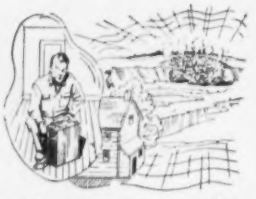

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To blast 305,000,000 tons of stone and nonmetal materials for America's ever-growing construction, road building, and steel industries requires more than 166,000,000 pounds of dynamite annually. Here, as illustrated above, is where explosives research pays off. Note the excellent fragmentation which minimizes secondary blasting . . . the low stone pile which increases and speeds up the production of the shovels.

Such results come not only from specially developed explosives and blasting supplies, but also by using the most modern blasting methods. Hercules' continuous research and extensive knowledge of field conditions are important to economical and efficient blasting in quarrying, coal mining, metal mining, and construction.

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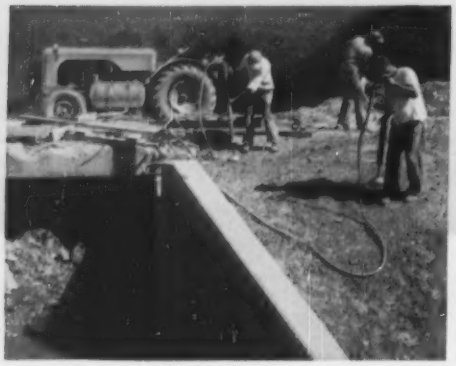
XR53-9

Tamping — Here's a Le Roi-CLEVELAND back-fill tamper air-powered by Tractair, that gives you faster, easier tamping, better compaction, lower costs. This example shows how Tractair teams up with Le Roi-CLEVELAND Air Tools to save time, work, money.



Cutting asphalt pavement — with a Tractair-powered Le Roi-CLEVELAND paving breaker. Note, Tractair in background is equipped with a sweeping attachment. This is just another of many ways that Tractair can save you money.

Drilling trench — Easy holding Le Roi-CLEVELAND sinkers provide the fastest way of drilling rock. The air-power source is a Tractair, equipped with a front-end loader. Tractair is extremely mobile. It has a low center of gravity. It takes money-saving air power anywhere.

LE ROI TRACTAIR

...the 10 in 1 machine that does 10 basic jobs to save you money

It holds down your investment in special equipment

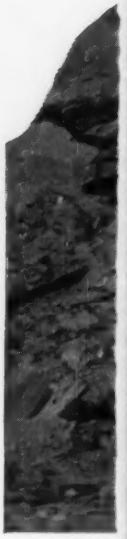
Because Tractair is a combination 35-hp wheel tractor and 105-cfm air compressor, it is extremely versatile.

It lets you take air power wherever you want it — air power for drilling rock, tamping fill, breaking concrete, driving spikes and form pins, or pumping water.

When it is equipped with attachments, you get added usefulness. You can load, back-fill, dig, sweep or hoist.

Although Tractair was pioneered and developed by Le Roi Company to do 10 basic jobs, its money-saving usefulness on costly, nuisance-type work is limited only by the user's imagination.

If you want to cut costs, get Tractair. Call your Le Roi dealer for a demonstration, or write us for further information.



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More Profits!

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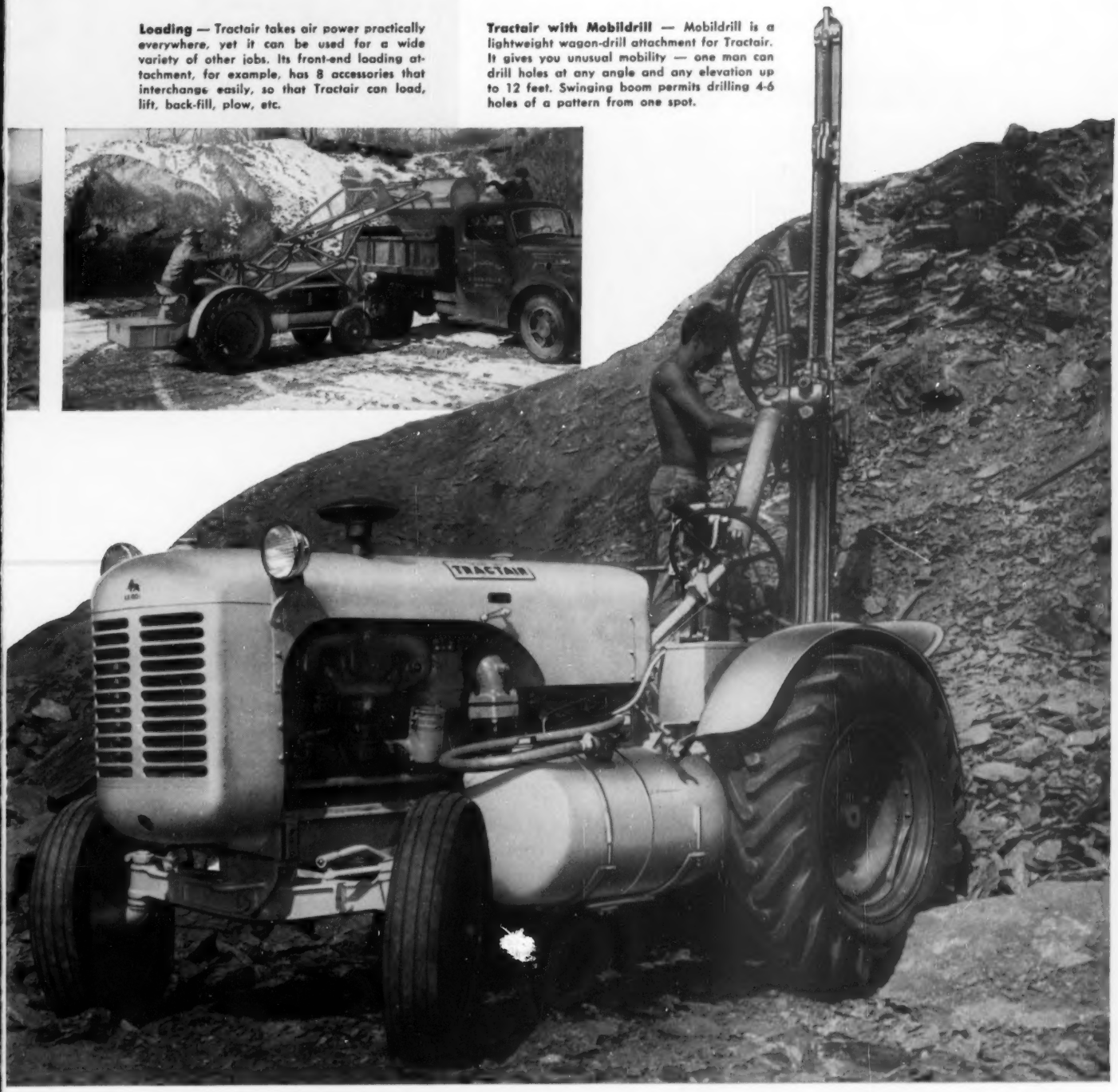
Tractair with Mobildrill — Mobildrill is a lightweight wagon-drill attachment for Tractair. It gives you unusual mobility — one man can drill holes at any angle and any elevation up to 12 feet. Swinging boom permits drilling 4-6 holes of a pattern from one spot.



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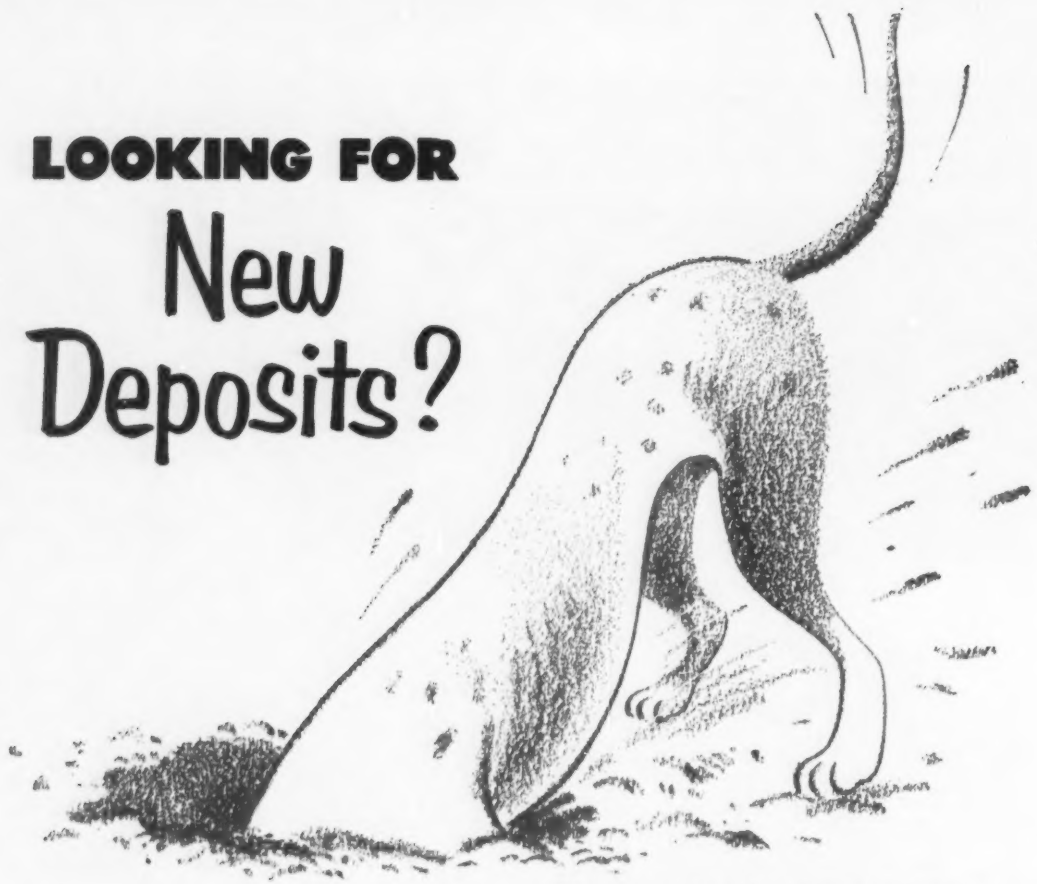

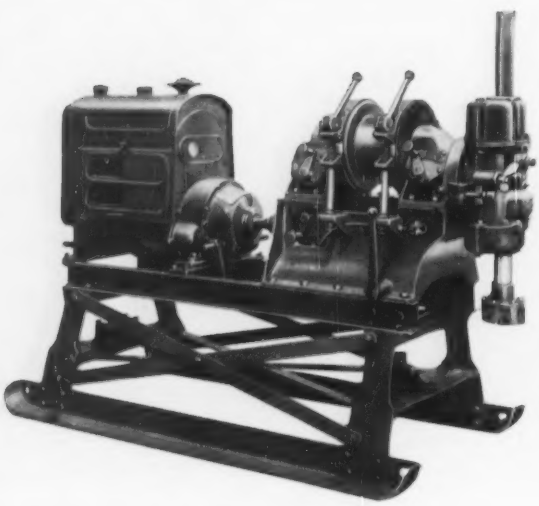

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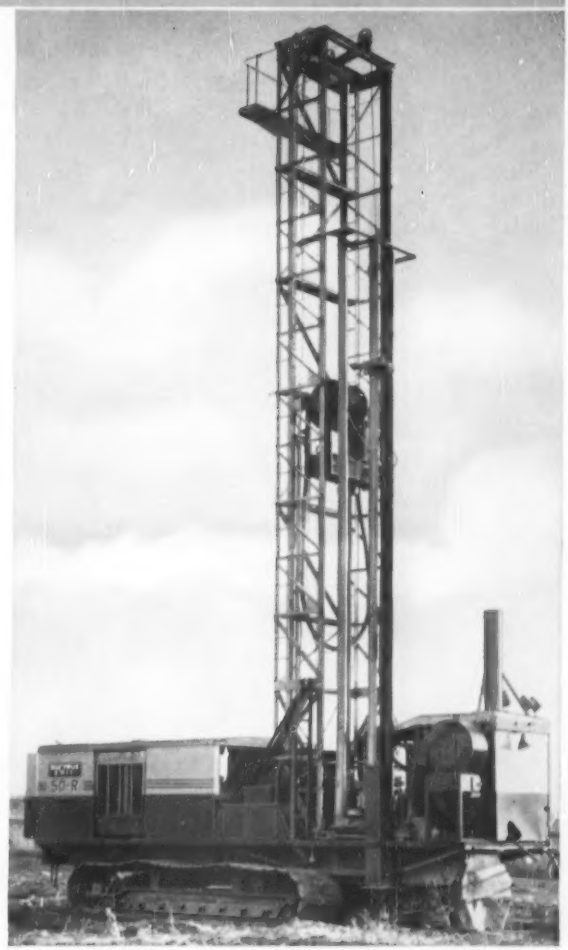

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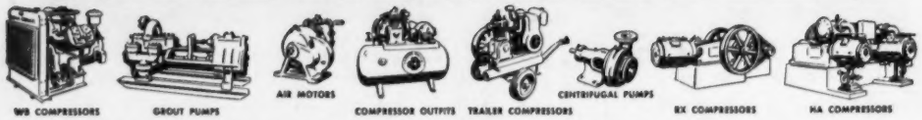

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